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FOOD-BORNE BACTERIAL POISONING



UNITED STATES DEPARTMENT OF AGRICULTURE

FOOD SAFETY AND INSPECTION SERVICE

More than 2 million cases of bacterial food poisoning occur every year in spite of advanced food processing techniques. Food-borne illness cannot be eliminated through inspecting meat and poultry processing by the U.S. Department of Agriculture nor the inspection of other food processing by the U.S. Department of Health, Education, and Welfare. Much food-borne bacterial poisoning can be prevented by proper handling, preparation, and storage of food in restaurants, institutions, and homes.

Because the bacteria that cause most of the food poisoning cases are everywhere in the environment, contamination of food is also universal. Prevention becomes a matter of stopping the growth of these bacteria or killing them at the proper time to prevent their causing food poisoning.

Four organisms--Staphylococcus aureus, a large group of bacteria lumped under the general category Salmonella, Clostridium perfringens, and Clostridium botulinum--are sources for most food poisoning cases.

The information in this publication is intended to provide brief selected facts about these bacteria for use by nutritionists, science writers, teachers, food managers, and others who need more than general information about the bacteria and the problem.

Staphylococcus aureus

Under the microscope, these bacteria appear as small, sphere-shaped organisms in pairs or short chains and sometimes in irregular grapelike clusters. They occur normally on the skin and in the nasal passages of humans and animals. The bacteria are particularly profuse in infected skin wounds and in boils, pimples, acne, and similar eruptions. The organisms can be expelled into the air in drops of moisture during breathing, talking, coughing, and sneezing.

This species of bacteria does not form spores. Spores are the dormant stage of bacteria and are resistant to heat, cold, and drying. In the laboratory, cultures of Staphylococcus aureus bacteria have lived for many months at room temperature or under refrigeration. When cultures were dried on fiber, paper, and cloth, or held in dried food, the bacteria survived many months also.

The bacteria in the food do not cause food poisoning. But when the bacteria are allowed to multiply in foods, they produce a toxin which is the agent that causes illness in humans. The bacteria are killed by temperatures as low as 140° F. (60° C.) maintained for 10 minutes. However, the toxin produced by the bacteria is highly resistant to heat, cold, and chemicals. Freezing, refrigerating, or heating foods at temperatures

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required for serving do not reduce the toxin significantly. The more toxin ingested, the greater the reaction by the body. The disease is rarely fatal.

The bacteria are introduced into the food during preparation, particularly by the food handler. If the food is allowed to stand at room temperatures above 44° F. (7° C.) for 2 hours or more, the bacteria begin to multiply. As the temperature of the food increases, growth of the staphylococci rapidly increases. As the bacteria grow, they may produce toxin when they reach levels of 500,000 per gram of food. Moist meat dishes and starchy foods provide an excellent medium for growth and are frequent sources of food poisoning. Types of foods in this class are eclairs, cream puffs, cake fillings, potato salads, and meat salads. Sliced meat such as roast beef, and particularly ham, are often involved. Because of the way they are handled, profuse bacterial growth and toxin formation can occur. Usually they are served without reheating; and, unless they are served soon after cooking, or refrigerated or frozen promptly, they become "incubators" for bacteria and the resultant toxin. The bacteria do not change the looks, taste, or odor of the food.

When food contaminated with a significant amount of toxin is eaten, the person usually experiences a sudden and violent onset of nausea, vomiting, and diarrhea within 2 to 4 hours. Abdominal cramps and prostration are common. Depending on the severity of reaction, the symptoms may last, in varying degrees, for 1 to 2 days.

Preventing food poisoning from Staphylococcus aureus is based on the following principles: (1) Avoidance of contamination of food by food handlers through personal cleanliness and use of sanitary

facilities and utensils; (2) use of sufficient heat to destroy the bacteria during cooking; and (3) immediate refrigeration or freezing of foods after preparation to retard the multiplication of bacteria before the food is served.

Salmonella

Salmonella is a general term applied to a group of about 2,000 closely related types of bacteria that cause food poisoning in humans. Under the microscope, all these types appear as short, thin rods. The bacteria do not form spores.

Salmonella bacteria occur frequently in the intestinal tracts of humans and other animals. They are shed in feces from both sources, and, for that reason, a cycle of infection is always present in the environment. The organisms are found in raw meats, poultry, eggs, milk, fish, and products made from them. Other sources of the organisms are food handlers and pets, including turtles, birds, fish, dogs, and cats. Insects and rodents are also sources of the bacteria.

Food contaminated by salmonella bacteria does not change in taste, odor, or flavor, so the presence of the organisms is not apparent.

The disease caused by salmonella bacteria is called salmonellosis. If food containing viable salmonella bacteria is eaten, the organisms multiply rapidly in the intestine, causing headache, diarrhea, abdominal discomfort, and, occasionally, vomiting. These symptoms appear within 24 hours after eating contaminated food. Most people recover in 2 to 4 days. Children under 4, elderly people, and people already weakened by disease sometimes become seriously ill. Death from the disease may occur.

Preventing food poisoning from salmonella is based on four principles: (1) Cooking foods thoroughly and serving them hot; (2) preventing recontamination of foods through cleanliness and use of sanitary utensils; (3) prompt cooling or freezing of foods after preparation to retard the multiplication of all bacteria; and (4) full reheating of stored foods to destroy bacteria.

Clostridium perfringens

Under the microscope, the vegetative forms of these bacteria appear as short, plump, encapsulated organisms, occurring singly or in pairs. The bacteria commonly inhabit the intestinal tracts of humans and other warmblooded animals. The organism produces spores which are resistant to heat, cold, and drying.

The spores appear virtually everywhere--in sewage, soil, dust, and food. To produce the vegetative form, the spores require warmth and certain anaerobic conditions (without air). Vegetative forms multiply profusely at 60° to 120° F. (16° to 50° C.). This form is killed by temperatures of 150° F. (66° C.) or above. However, the spores can survive temperatures of 212° F. (100° C.) for 1 hour or more. Vegetative forms are reduced in numbers in stored foods when the temperature is 40° F. (4° C.) or lower. (The vegetative form is the multiplying stage of the bacterium as distinguished from the spore form--the dormant stage).

Food poisoning from this bacterium is associated with meat and poultry and other high-protein foods that have been improperly cooked or stored. Risk of food poisoning in such instances occurs when large amounts of food are held in containers on steam tables while

being served and overnight, as in restaurants and institutions. An anaerobic condition is produced in meat when air is eliminated by heating, thus allowing surviving spores to germinate and multiply rapidly in warm foods. Large numbers of this bacterium result in food poisoning.

Symptoms of *perfringens* poisoning will begin in 8 to 24 hours (usually in 12) when food containing large numbers of the vegetative form are eaten. Signs of the disease include diarrhea and gas pains, all usually subsiding in 24 hours. Nausea and vomiting rarely occur. This disease is rarely fatal.

These bacteria are so widespread that it is impossible to reduce their incidence. Consequently, either the spore form or the vegetative form should be assumed to be present in foods.

Preventing food poisoning from *Clostridium perfringens* is based on three principles: (1) Cooking high-protein foods (meat and poultry, particularly) well enough to kill vegetative forms of the organisms; (2) keeping foods hot--above 140° F. (60° C.)--until eaten; and (3) prompt refrigeration of foods in shallow containers for quick temperature reduction to retard the multiplication of vegetative forms that cause disease.

Clostridium botulinum

Under the microscope, these bacteria appear as rod-shaped organisms occurring singly or in short chains. They are slightly motile through action of 4 to 20 flagella (bacterial structures of locomotion). The bacteria form spores that occur throughout the environment--in soil, water, and on produce and other foods. The spores are harmless unless triggered to divide by certain

conditions. The vegetative forms, derived from the spores, reproduce under anaerobic conditions (without air). Anaerobic conditions occur in the deeper parts of food products even when the products are exposed to the air.

When the bacteria are in a low-acid food, they multiply and produce a toxin that is the agent responsible for the disease called botulism. The disease is rare but often fatal. Since 1925, fewer than 10 deaths have been reported caused by food canned commercially, while about 700 deaths have occurred from ingesting home-canned foods.

For high-acid foods, such as tomatoes, and fruits, boiling--212° F. (100° C.)--will destroy the vegetative form. Spores may survive but are unable to germinate and grow in high-acid canned foods. Higher temperatures, attained only by pressure cooking--240° F. (116° C.)--are required to kill the spores in low-acid foods. Low-acid foods include meat and poultry, fish, string beans, beets, corn, and some fruits. As the bacteria multiply and produce the toxin, they also produce variable amounts of gas. Some strains produce a foul odor, while other strains do not. Minute amounts of the toxin can be fatal if ingested.

When the toxin produced by the bacteria is ingested, signs of

botulism usually occur in 18 to 36 hours, but may appear in a few hours or as long as 8 days after ingesting the toxin. Symptoms of botulism include general weakness, constipation, some headache followed by double vision, impaired speech and difficulty in chewing and swallowing. The disease frequently results in death within 3 to 7 days unless treatment is initiated promptly at the onset of symptoms.

Prevention of botulism is based on five principles: (1) In canning foods of low acidity (green beans, for example), use pressure cookers and cook long enough, with high enough temperature and pressure to destroy the spores; (2) in canning of foods of high acidity (tomatoes, for example), cook at boiling temperatures in strict accordance with canning instructions to kill the vegetative form and yeasts and molds (spores cannot grow in high acid foods); (3) avoid tasting or eating canned foods from containers showing the following defects: leaking, bulging, or severely damaged cans; cracked jars or jars with loose or bulging lids; (4) avoid tasting any canned foods that spurt liquid when the container is opened or any canned food that has an abnormal odor or appearance; and, (5) boil low-acid, canned foods for 10 minutes prior to serving.